Vegetable Oils That The United States Needs From the American Tropics 1/

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The United States is the world's largest consumer of fats and oils, and is also one of the largest producers of these commodities. However, despite the large production of fats and oils, the United States must annually import approximately 2,000 million pounds of oil which, for various reasons, cannot be produced domestically. All but a few of these imported oils, or the corresponding oil-bearing materials, are either produced, or are capable of being produced in the Americas.

Fats and oils may be classified in four groups depending on their mode of utilization. These groups consist of the edible oils, soap oils, drying oils, and miscellaneous specialty oils. The importance of fats and oils in the domestic economy, as well as the extent of the dependence of the United States on imports, may best be illustrated by a few selected statistics for the last year prior to the disruption of normal trade resulting from the entry of the United States in World War II. In 1941, consumption of fats and oils reached an all-time peak of slightly less than 11,000 million pounds.

Of the 10,942 million pounds of fats and oils consumed in the United States in 1941, more than half represented factory consumption, i.e., were processed into products such as shortening, soap, paints, varnishes, synthetic resins, etc., prior to consumption. Imports of fats, oils, and oil equivalent of oilseeds has varied in recent years from 1,500 to 2,500 million pounds, or about one-fifth to one-quarter of the total consumption of these products.

Many of the imported oils and oilseeds, including coconut oil and copra, palm oil and kernels, tung, perilla, and rapeseed came principally from the Far East and at present are generally unavailable owing to occupation by the enemy of the countries of origin, or to dislocation and lack of shipping facilities. Other oils and oilseeds including flaxseed, castor seed, oiticica oils, babassu kernels, and carnauba wax are normally imported mostly from South America in considerable volume. In addition to these products a number of other oil-bearing nuts or kernels of South American origin, including tucum, murumuru, cohune and ouricury are imported

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in small quantities. The last mentioned group, consisting of oil palm nuts, are at present urgently needed to replace copra and coconut oil formerly imported from the Far East.

Data with reference to imports of oils, oilseeds, and oilseed cake originating in Latin America as reported in Fats and Oils Trade of the United States (1) are given in Table 1.

Edible Oils

Normally the United States produces an excess of edible oils, and exports from 250 to 500 million pounds. Although practically every edible fat or oil of domestic origin is included in these exports, the principal item of this group is lard, which may account for as much as half or more of the total exports.

Many factors have tended to increase the demand for edible oils in the present emergency, but to some extent increased production fostered and encouraged by the United States Department of Agriculture will tend to offset this demand by a correspondingly increased supply. Therefore, unless the United States is called upon to furnish unduly large quantities of these oils to less favorably situated countries composing the United Nations, imports of edible fats and oils may not be much greater than normal. If increased quantities need to be imported, it is probable that they will consist principally of cottonseed oil and tallow. Brazil and Argentina, respectively, would probably be in the best position to supply these products. Certain palm kernel oils might be included but they are more urgently needed for other purposes.

Soap Oils

Approximately 2,000 million pounds of fats and oils are annually consumed in the United States in the production of soaps and related products. Ordinarily about 65 to 70 percent of this consumption is represented by animal fats, fish and marine oils, and smaller percentages by stearin-type vegetable oils, such as soybean, corn, cottonseed, and peanut, practically all of which are of domestic origin.

However, the production of certain types of soap products, including free-lathering soaps, especially for use in hard water, and for laundering fine fabrics (silk, rayons, nylon, woolens, etc.), toilet soaps, shaving soaps, and textile processing soaps require the use of certain oils produced outside of the Continental United States. Coconut oil is the principal and best known representative of this group of oils. The value of this oil to the soap-maker is dependent on its chemical composition. Coconut oil and a few other oils including babassu and palm-kernel contain approximately

50 percent of lauric acid, and less than 20 percent of fatty acids having a chain length greater than that occurring in palmitic acid. (2) The presence of lauric and similar acids in coconut and related oils is responsible for the free-lathering property of soaps made from these oils. (See Table 2).

The quantities of coconut-type oils used for edible purposes in the United States has been steadily decreasing in recent years and will probably disappear altogether during the war. However, this loss will not be greatly felt since equally serviceable products can be produced by the hydrogenation of domestic oils. The same statement does not hold with respect to the quantities of oils normally used in the production of soaps and soap products.

Prior to the beginning of hostilities in the Pacific, coconut and palm-kernel oils were imported primarily from the Philippines and the Dutch East Indies. Small quantities of these oils were obtained from South and Central America and West Africa. In recent years, the use of Far Eastern palm-kernel oil for soapmaking purposes has been decreasing, and the use of Brazilian babassu oil for the same purpose has been increasing.

In order to understand the nature of the problems involved in developing these resources, the past and present status of some of the more promising of these oils will be reviewed.

Babassu Oil: Brazil abounds in a species of palm known botanically as *Orbignya barbosiana* Burret 2/, and locally as babacu or babassu in English. The actual extent of the distribution of this palm, the number of trees, and the potential yield of oil are unknown.

The tree grows wild in the States of Maranhao, Amazonas, Bahia, Para, Piauhy, Ceara, Matto Grosso and Goyaz. The same or closely related species are reported in Mexico. Creditable reports place the number of babassu palms in the State of Piauhy as 400 million and in the State of Maranhao as 200 million. Most of the exports originate in the latter State.

Much of the country which abounds in babassu palms is sparsely settled and impenetrable since neither highways nor railroads traverse the tropical forests. Collection of the nut is, therefore, practicable only in areas adjacent to river transportation. After the nuts are gathered, there remains the problem of cracking them and separating the kernels in a condition suitable for transportation.

2/ The nomenclature used in reference to oil palms and other tropical plants is that currently followed by the U. S. Department of Agriculture and was kindly furnished by the Division of Plant Exploration and Introduction, Bureau of Plant Industry

The kernels are encased in a very hard more or less elongated or elliptical shell. The nuts are cracked by hand labor in a very primitive fashion and the work is extremely arduous. The kernels are usually separated from the cracked nuts by women and children. Reports relative to the average daily production vary from 10 to 45 pounds of kernels per worker. Many attempts have been made to develop and introduce machines to perform this cracking operation, and although several machines have been manufactured and placed on the market, they have not been used to any appreciable extent.

According to the report of the U. S. Tariff Commission, (3), "several unsuccessful attempts at large scale exploitation of the babassu forests have been made by foreign firms. The failure of these attempts is attributed to the difficulties of gathering and transporting the nuts, and particularly to the unavailability of a satisfactory machine for cracking their hard thick shell." Recently a large North American firm of food processors has, with financial assistance from Brazil, undertaken the large scale development of the babassu oil industry.

Early this year a commission of vegetable oil experts, representing various agencies of the United States Government and industry, visited Brazil at the latter country's invitation to obtain first-hand information concerning the problems requiring solution, and to offer suggestions as to the best method of furthering the development of the babassu and other vegetable oil resources. (4).

Tucum and Murumuru Oils: Several species of Astrocaryum palms, including Astrocaryum tucuma Mart., found in Central and South America, including Brazil, the Guianas, and Venezuela, produce nuts known under a variety of local names but are generally known to the trade as tucum. The oil of the kernels is similar to babassu and coconut oils and can replace these oils in the soap kettle and in edible products. The kernels usually yield about 44 percent oil under ordinary processing conditions.

Another species of Astrocaryum palm, Astrocaryum murumuru Mart., which is found principally in Brazil, produces nuts containing a lauric acid-type oil similar to coconut and babassu oils. The yield of oil from the kernels is about 36 percent. Small quantities of both tucum and murumuru kernels were probably exported from Brazil to the United States from time to time prior to 1936, but in that year, importation of these kernels in volume began and has continued since then. Recent statistics covering imports of these kernels are given in Table 3.

The average annual imports during the 5-year period, 1937-41, were 8 million pounds of tucum kernels and 5 million pounds of murumuru kernels. The estimated oil production, assuming yields of 44 and 36 percent, respectively, are 3.5 and 1.8 million pounds annually.

Miscellaneous Lauric Acid-Type Oils: In addition to the oils discussed above, a number of other lauric acid-type oils abound in various parts of tropical America countries, among which may be mentioned cohune, corozo, macanilla, coyol, coquita, and ouricury. Small quantities of nuts, kernels, or oils of these palms have been, or are being, imported into the United States but data on the exact amounts of each are not known since they are not separately reported but are grouped under miscellaneous oil or oilseed imports.

Cohune oil is obtained from the kernel of the seed or nut of the cohune palm, Orbignya cohune (Mart.) Standl., which is found in the tropical lowlands in the Yucatan Peninsula in Mexico, British and Spanish Honduras, Guatemala and certain other regions. Small quantities of this oil are produced locally in these countries. At the present time, cohune nuts are being imported principally from Honduras. The whole nuts, and also kernels, are shipped by boat to Mobile, Alabama, where for the past several years they have been regularly crushed for oil. According to recent information, collection facilities are being expanded and machines are being installed at points of collection in Honduras and elsewhere to crack the nuts and separate the kernels.

The coyol palm, Acrocomia mexicana Karw. ex Mart., is found in many Central American areas, including Nicaragua, Costa Rica, Guatemala, and Panama. The nuts are extremely hard and difficult to crack, which appears to be the principal reason that they have not been found in commerce to any extent. The kernels contain 48 to 50 percent of oil.

Corozo (Mamarron) oil is obtained from the kernels of the palm, Corozo oleifera (HBK.) Bailey, which is found in Central America, especially in Venezuela. Macanilla oil is obtained from the kernels of the palm, Guilielma gasipaes (HBK.) Bailey, which is found in the same general area as corozo. Both of these palms are being exploited at the present time as a source of lauric acid-type oils. A satisfactory cracking machine has been developed for these nuts, adequate finances are available, and with proper organization of labor, transport, and government cooperation, the industry should be successful.

Ouricury oil is produced from the kernels of the palm, Syagrus coronata (Mart.) Becc., which is found in Brazil and Central America. Recent figures are not available, but in 1938 Brazil exported 3,548 tons of these kernels for the production of oil, of which 3,398 tons went to the United States.

The coconut oil palm, Cocos nucifera, grows along the coastal areas of practically every country. It has been estimated that South America possesses more than 500,000 acres of coconut palms and

the West Indies at least 110,000 acres. Considerable quantities of fresh coconuts and dried coconut meats or copra have been imported into the United States from the Caribbean region, primarily for edible purposes. Practically all of the imports of copra for oil have come from the Far East, principally the Philippines.

Several factors are, in various degrees, responsible for lack of appreciable copra imports from tropical America for crushing purposes. One of them is the fact that the fire-cured copra from the Caribbean region is inferior to the sun-dried copra of the Philippines for the production of oil. Another reason is the fact that a processing tax of 5 cents a pound is levied on all copra which does not originate in the Philippines. A third reason is the fact that the copra industry has long been established on a large scale in the Philippines where an abundant and relatively cheap supply of labor has resulted in a competitive advantage. Removal of the processing tax on copra, at least for the duration of the war, undoubtedly would lend encouragement to the production and importation of copra from the Caribbean region, especially since the shipping problem is less difficult by comparison with the more distant Far Eastern area.

It is not possible to discuss all of the various species of palms abounding in tropical America which represent sources of lauric acid-type oils suitable for soap-making purposes. The examples cited are sufficient to indicate the vastness of these supplies. Many of these products are already items of commerce even though the volume is still small when compared to the 750 million pound annual market for coconut-type oils which exists in the United States.

With the exception of coconut oil and copra, the problems involved in their commercial development are similar and may be summarized as follows: (1) The palms that form the sources of these oils are more or less widely scattered, most of them in tropical jungles; (2) machinery for cracking the nuts and separating the kernels still requires development, although some half dozen machinery manufacturers are now engaged on the problem of developing suitable machines, and (3) until recently, little money and technological skill have been available. At the present time, a number of firms with adequate finances are operating in Brazil, Venezuela, Ecuador, Honduras, and elsewhere, and other concerns are contemplating entering this field.

On the other hand, practically all of the kernels or oils, with the exception of coconut, are not subject to import or excise duties by the United States; the potential market is extremely large; and the distances from ports of export to ports of import are materially shorter than those of the Far Eastern trade routes.

There is every reason to believe that the time is most opportune to establish an American oil palm industry on a large and permanent scale.

Drying Oils

Third in order of volume, are the oils consumed in the drying oil industries. Consumption of these oils in recent years has varied from 670 million to 1,053 million pounds, annually. The principal oils of this group are linseed, tung, fish, soybean, castor, oiticica, and perilla in the order named. (See Table 4.)

These oils may be divided into two sub-groups consisting of the fast-drying oils and the ordinary drying oils. The first group consists of tung, oiticica, and dehydrated castor oil; and the second group of linseed, perilla, fish, and soybean oils. At present, the greatest need in the United States is for oils of the fast-drying group, especially as a replacement for tung oil which was formerly imported from China.

Tung oil is the most valuable of the drying oil group because its speed of drying and the water resistance of its films are second to none. In conjunction with rosin esters or synthetic resins, it makes the very highest grade varnishes. It is essential for making certain insulating compounds for electrical generators, cables, and wires; as an important ingredient of many types of brake linings, gaskets for steam pipes, pumps, and engines. It is also used in the manufacture of linoleum and oilcloth, for waterproofing raincoats, and in the production of linings for metal containers used in the food industries. In 1940, about 90 to 95 percent of the factory consumption of tung oil was used in the production of varnishes and paints. In normal times the automobile industry uses particularly large amounts.

Tung or China wood oil is obtained from tung nuts. The tree is indigenous to China where its cultivation has, until recently, been haphazard. For the most part, oil expression is carried out by primitive methods and the cost of production is correspondingly low.

Before the Chinese-Japanese hostilities began, most of China's tung oil found its way to Shanghai and Hongkong for export. As conditions in the Orient made it increasingly difficult to obtain, the price of tung oil has risen from a low of about 5 cents per pound f.o.b. New York, in 1932-3, to approximately 36 cents, at the present time. The shortage has become progressively more acute and intense efforts have been devoted to the development of substitutes. Production of replacements has been retarded, to some extent, by the probability that post-war conditions will cause tung oil prices to drop to 10 or 12 cents per pound. At present, however, practically no shipments are being made, and it is unlikely that there will be any appreciable movement of this oil for the duration of the war.

Increasing difficulties in obtaining supplies of tung oil from China have stimulated other countries to grow tung trees. The most extensive of these plantings comprise about 75,000 acres in the United States. Brazil has some fairly extensive experimental plantings, and smaller acreages are in cultivation in Argentina, Paraguay, Peru, and Mexico. It is reported that the number of tung trees in the State of Sao Paulo now exceeds 700,000. The production of tung nuts amounted to 350 tons in 1939, the latest year for which figures are available, but it is believed that the 1942 yield will be many times that figure. A modern plant for the extraction of oil is being erected (6). Argentine tung oil production in 1939 and 1940 was 219 and 278 thousand pounds, respectively. However, in spite of these plantings, the requirements for tung oil during the present emergency will have to be met almost entirely with oiticica and castor oils.

Oiticica Oil: In general, oiticica oil is used as a replacement for tung oil, and its demand is, therefore, closely related to that of tung oil. In varnishes, it lacks the durability of tung oil and it is somewhat harder to handle during formulation and cooking. Since all available oiticica oil will be used as a replacement for tung oil, the demand should be considered as being the same as for tung oil, or approximately 150 million pounds annually for the duration of hostilities.

Oiticica oil is obtained from the nut of the oiticica tree, Licania rigida Benth., which grows along rich alluvial river banks in the States of Rio Grande do Norte and Ceara in Brazil. The States of Maranhao and Parahyba have smaller numbers of trees. The kernel contains 50 to 70 percent oil. The trees which are uncultivated, bloom from July to October, principally in September, and the seeds ripen about four months later. The seeds are gathered by hand and are sent to collection depots, whence they are transported to the extraction mills.

The oiticica oil industry was scarcely known outside of Brazil prior to 1935. For a number of years thereafter, great secrecy surrounded the origin of oiticica oil, and the Brazilian government has taken elaborate precautions to protect the industry. Although some oiticica nuts were exported prior to 1937, heavy penalties are now provided for shipping the seed out of Brazil. There are similar laws against damaging or felling oiticica trees. Systematic harvesting and distribution methods have been introduced, and modern extraction mills have been built. (See Table 5).

Because of the lack of accurate information relative to the size of the oiticica industry and the number of trees in production, it is difficult to predict the extent to which the United States can depend on this oil in the present emergency. It is estimated that there are a million trees in Ceara alone. If it is assumed that

each tree annually yields 220 pounds of nuts containing 74 percent of kernels, an accelerated production program might produce about 80 to 100 million pounds of oil per year. Accurate information on the potential production of nuts and the available capacity for processing them is badly needed.

Caster Seed and Oil: The most widely used substitute and supplement for tung oil at the present time, is dehydrated castor oil. Castor oil is not a drying oil, but it can be catalytically dehydrated to produce a product which dries rapidly to form a water-resistant, non-yellowing film.

Its drying properties resemble, in a lesser degree, those of tung oil; it dries more slowly and the resulting films are less resistant to water. A further serious disadvantage is the development of after-tack, but it does excel tung oil in non-yellowing properties and for the latter reason, it finds extensive use in many fields where tung oil is unsuitable. Enamels in white and various light shades are formulated with dehydrated castor oil to enhance their color retention. It is also used to produce wrinkle finishes. However, the remarkable increase in the consumption of dehydrated castor oil within the past two years is due mainly to its ability to replace tung oil which has been steadily becoming scarcer and more expensive.

Castor oil is employed extensively in the production of products other than protective coatings. Gasket materials are peculiarly unaffected by castor oil, and it is, therefore, the principal ingredient in most hydraulic pressure fluids used in military as well as in civilian conveyances, instruments and machinery. Its comparatively uniform viscosity over wide temperature ranges is also a great advantage in this connection. In brake systems, aircraft control systems, and similar applications, it is used in admixture with isopropyl alcohol or a similar liquid.

Castor oil is an ingredient in the binder used in incendiary bombs. In artificial leather, 50 percent of the coating material is castor oil, and this use alone accounted for approximately 20 percent of the consumption prior to 1938. At the present time, serious shortages threaten in practically all types of leather which has resulted in increased demand for artificial leather, the production of which consumes large quantities of castor oil. Sulphonated castor oil is used as a mordant in finishing cotton and wool fabrics of the types used in military uniforms. Prior to 1938, this use accounted for approximately 25 percent of our castor oil consumption. The ability of castor oil to break emulsions is also of extreme importance, particularly in the petroleum industry where very large quantities are used for this purpose.

Imports of castor seed have varied from 114 to 394 million pounds during the past six years as is indicated in Table 6. Formerly large quantities of castor seed were imported from British India, but in recent years, these imports have been entirely supplanted by imports from Brazil and Haiti. (Insert Table 6).

According to a report of the U. S. Tariff Commission (5) "the seed of the castor plant, which is a perennial in the tropics and an annual in the temperate zones, is gathered principally by a large number of producers as a side line. The seed is picked from wild or semi-cultivated plants, growing for the most part in out-of-the-way places on waste land, around houses, on the margins of gardens, fields, and roads, or interplanted with other crops. The plants must be picked over several times as the seeds ripen."

Ordinarily, castor seed cannot be grown in the United States in competition with South America where the plant is uncultivated. In the first place, only annual varieties can be raised satisfactorily in this country, whereas, Brazilian plantings are perennial, having a total useful life of five or six years. Furthermore, the producing areas in Brazil are extremely dry during the harvest season, and the dryness makes threshing fairly easy. The chief factor, however, is the low-priced labor available in Brazil for the large amount of hand work involved in harvesting and handling the crop.

It is difficult to obtain an accurate estimate of the potential production of castor seed in Brazil because the amount harvested depends upon the price which, in turn, depends upon the export demand. The 1940 crop was estimated at 165,000 short tons compared with 139,000 in 1939. Persons familiar with the castor oil industry and with Brazilian production believe that a production goal of 250,000 short tons annually is not too high and could probably be reached or closely approached if proper price inducements were offered.

Considerable experimental work is being carried on in Caribbean and Central American countries with the view to introducing the castor plant as a cultivated crop. Argentina produces small quantities of castor seed, estimated at about 2,000 tons annually. Consideration is said to have been given to growing castor seed as a cultivated crop in Argentina, Venezuela, Colombia and elsewhere in Latin America.

Castor seed enters the United States free of excise tax but is subject to a duty of 1/4 cent per pound. The trade agreements with Brazil and Columbia bound the excise tax free and reduced the prior duty from 1/2 to 1/4 cent a pound.

Even though tung oil may recapture, after the war, part of the market it previously held in the United States, the demand for castor oil will still remain relatively large, since it possesses inherent characteristics not found in other oils. Consequently, there should be a ready market in the United States for a very large portion of the castor seed produced in South America.

Flaxseed: Linseed oil, the product derived by crushing flaxseed, is the most important drying oil to the United States in point of volume. Ordinarily it accounts for approximately three-fourths of all the

oils used directly and indirectly in the drying oil industries.

The principal sources of flaxseed in the Western Hemisphere are Argentina, the United States, Uruguay and Canada in the order of production. (See Table 7).

The principal use to which linseed oil is put is in the manufacture of paints and varnishes for protecting nearly all types of surfaces from damage by the elements. Linoleum and other floor coverings are produced mainly from oils of the linseed oil type. Oilcloth and other coated fabrics also depend upon the use of these oils to impart to them their impervious surfaces. Printing inks consist mainly of such oils. One of the most essential uses for linseed and similar oils is a core binder for foundry sands. Needless to say, the manufacture of practically all machinery, military and otherwise, would become impossible if the supply of core oils for producing castings should be interrupted. These oils are also consumed in large volume for manufacturing alkyd resins.

The United States is the largest consumer of flaxseed for oil (See Table 8) and Argentine the largest producer. The latter country produces approximately one-half of the world production of this seed. Flax is grown in the Parana River Basin in Argentina and in Uruguay in the region north and northeast of the Rio de la Plata. Seeding occurs from May to September and harvesting from December to January. The weather in Argentina is erratic, and heavy rainfall or dry weather influences the yield which is reflected in the wide range of production over a series of years.

In Argentina, the flaxseed surplus is extremely acute because European markets have been closed since the start of the war. The third official estimate of this season's crop of Argentine linseed puts the probable aggregate yield at 1,600,000 tons. Some portion of the total, possibly up to 400,000 tons, will be required for seeding and for the increased domestic production of linseed oil contemplated in order to facilitate transport. With a large carry-over from last season the Argentine Government had a prospective total of linseed available for export of considerably over two million tons, possibly a record. During the past few months this carry-over may have been reduced by approximately 250,000 tons, but this leaves a very substantial balance still to be disposed of, and adequate buying interest is not yet in sight. Exports to Europe, a once valuable market, have shrunk almost to zero, and shipments to the United States to supplement domestic supplies have not assumed the desired proportions owing, in the main, to the great difficulties of sea transport.

Miscellaneous Specialty Oils and Waxes

The fourth and last group of oils in point of volume, is designated as "miscellaneous specialty oils and waxes." It contains a wide diversity

of oils which are consumed in an equally diverse group of processes and manufactured products. For the most part, these oils and waxes are produced outside Continental United States. Among these products are palm oil, which is used in the production of tin and terne plate; olive oil, used in the production of textiles; sesame oil, used in pharmaceuticals, and the various waxes such as carnauba, Japan, and candelilla, used in polishes, insulation, electrical devices, paper and textile coating, cosmetics, etc. It also includes that portion of castor oil which is not used in the drying oil industries.

Palm Oil: Palm oil is consumed in the production of shortening, oleomargarine, and soap, and in the manufacture of tin and terne plate, and in the cold rolling of sheet steel (See Table 9). Its use in edible products has in general been decreasing in importance in recent years, and its use in certain types of soaps while desirable, is not indispensable. For use in the tin and terne plate industry it is considered indispensable and the belief has been widespread that no other oil can satisfactorily replace it for this purpose.

There is no domestic source of palm oil. In the past, the oil has been imported primarily from the Dutch East Indies, although some imports originated in West Africa. At the present time, practically all imports of palm oil from the Dutch East Indies have ceased and there is little prospect of obtaining oil from West Africa owing to the British requirements which have to be met from this source, and to the unavailability of the necessary tankers or cargo space for drum shipments. (See Table 10).

Palm oil is produced from the fleshy pericarp of the fruit of numerous varieties of the African palm, Elaeis guineensis. It is now extensively cultivated in the Dutch East Indies, British Malaya, and in the Belgian Congo.

Besides palm oil, which is produced from the pulp or pericarp surrounding the kernel of the African palm, there is also produced palm-kernel oil from the kernels of this fruit. Palm-kernel oil differs chemically and in its uses from palm oil, and the two oils should not be confused. Palm-kernel oil is similar in its composition and uses to coconut oil and can replace this oil in most applications, especially in the production of free-lathering hard water soaps. Many of the palms of tropical America yield coconut-type oils, but few, if any, produce appreciable quantities of pulp or pericarp oils. The pericarps of most of these palm fruits are quite thin and contain only a small percentage of oil.

For many years the wild African palms furnished all of the palm oil of commerce, but in recent years large quantities of high grade oil have been produced and exported from Sumatra. The oil palm was first introduced from West Africa into the Dutch East Indies in 1848, but it was not until 1910 that the present plantation system of production had its beginning. Under favorable soil and climatic conditions, the

palms begin to bear in four years and when eight years old, reach a high yielding state.

The oil palm was also introduced into Brazil from Africa but no plantation system similar to that of Sumatra was ever established and no attempt was made to improve the stock. It is unlikely that these scattered palms can be considered as a potential source of this oil. However, there appears to be no valid reason why a plantation system of palm cultivation similar to the Sumatran and Belgian Congo developments could not be established in tropical America, especially Brazil. Both soil and climate are ideal, processing methods are well known and can be adapted to South Western Hemisphere conditions, and a supply of labor and transport can be developed. In all probability, planters and experienced personnel, and possibly seed stock could be obtained from the East Indies. If a plantation system could be established in the near future, the Western Hemisphere could, within a few years, be forever freed of dependence on the Far East and West Africa for supplies of this vitally needed oil.

Vegetable Waxes: With the exception of beeswax and montan wax, practically all of the non-mineral hard waxes used in the United States are imported. They include carnauba, principally from Brazil, candelilla from Mexico, and Japan wax from Japan, as its name implies. Even before the advent of the present war, importations of carnauba and candelilla waxes from the American tropics were generally increasing, and imports of Japan wax from the Orient were decreasing. (See Table 11).

Carnauba Wax: Carnauba wax production is confined practically to Brazil, principally to the States of Ceara and Piauhy, although a small amount of wax comes from the neighboring states of Maranhao, Rio Grande do Norte, Pernambuco and Parahyba. The wax is obtained from the leaves of the carnauba palm, Copernicia cerifiera (A. Camara) Mart. Production amounts to approximately 10,000 tons annually.

As a result of explorations carried out in 1935 by one of the largest consumers of carnauba wax in the United States, considerable information is available concerning the extent of the resources and the possibilities of future development of the carnauba wax industry (7).

The wax is used in the manufacture of polishes for floors, automobiles, furniture, shoes, etc., in candles to raise the melting point, in carbon paper and duplicating stencils, and in the manufacture of phonograph records and a variety of other molded products. Despite considerable research work, no synthetic substitute has been found which can successfully replace carnauba wax in many of its uses.

The wax is produced by primitive methods, but efforts are being made to improve them, and at least one American concern now maintains a laboratory and experiment station in Brazil where work is in progress

on methods of improving both the quality and yield of wax. This work is particularly significant because, although the carnauba palm grows over a vast area in Brazil, it is only in the region of exceptional aridness that the palm produces commercial quantities of wax.

Some landowners have experimented with the production of the carnauba palm on a plantation system, but since the tree grows very slowly, attaining a height of only about 5 feet in 20 years, the success of these ventures will not be known for years to come.

Candelilla: The product known as candellila wax is found on the stems of a plant of the Euphorbiacea, Pedilanthus pavonis (Kl. and Garcke) Boiss, which grows in the semiarid regions of Northern Mexico and Southern Texas. Most of the commercial wax production comes from Mexico. The plant, which grows to a height of 3 to 5 feet, consists of a bundle of stalks without leaves. Each plant yields 3.5 to 5 percent of wax.

Summary and Conclusions

The vegetable oil resources of the American Republics have been reviewed in the light of the needs for these oils in the United States.

It is evident from the data presented, that the Western Hemisphere could be almost entirely self-sustained with regard to its vegetable oil needs and could produce additional quantities for export outside of this Hemisphere.

In normal times, the United States produces a surplus of edible fats and oils, but requires large quantities of other oils for use in the manufacture of soap, paints and varnishes, and specialty products. Vast potential resources of practically all of the desired oils exist in the warmer parts of the Americas and merely await intensive and large scale exploitation. A few others, such as palm oil, could be developed through the establishment of a plantation system similar to that existing in the East Indies.

The oils which are most needed by the United States are the coconut or lauric acid-type oils represented by babassu, tucum, murumuru, cohune, corozo, macanilla, coyol and ouricury obtained from various species of tropical palms.

Among the drying oils needed are oiticica, linseed, and castor; as well as the hard waxes, carnauba and candelilla.

All of these oils and waxes are derived from wild trees and plants with the exception of linseed and some castor seed. One species of palm, Elaesis guineensis, is not now grown in the Americas but could be established on a plantation basis much to the benefit of the entire Western Hemisphere.

The American Republics possess many natural advantages in the development of its vast resources of vegetable oils, especially in relation to trade with the United States. These are the nearness of markets; absence of tariff barriers for most oils (linseed, castor, and coconut are exceptions); and a large and steady demand.

The obstacles to the development of these resources are the vastness of the areas of production; sparseness of population; lack of adequate transport and labor; lack of simple, inexpensive, and self-contained machines for cracking certain types of oil-bearing nuts; lack of adequate and sustained financial interest; and to some extent lack of technologists familiar with the problems of oil production. Some of the problems of finance, technology, and development of machinery are being attacked with vigor and will no doubt be solved.

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Table 1. - Oils and oil-bearing materials imported from Latin America, 1938-40.

	1938	1939	1940
	1,000 pounds	1,000 pounds	1,000 pounds
Argentina			
Flaxseed	303,168	855,533	552,806
Glycerine	2,061	2,910	2,906
Cottonseed cake	-----	-----	3,951
Peanut cake	-----	----	6,114
Brazil			
Babassu kernels	50,826	115,856	98,272
Carnauba wax	12,543	16,551	16,025
Castor beans	115,020	161,926	163,116
Cottonseed oil	51,965	25,022	11,359
Murumuru kernels	4,101	7,504	6,001
Oiticica oil	5,500	13,380	15,556
Tucum kernels	3,528	9,810	5,032
Cottonseed cake	-----	-----	60,808
Haiti			
Castor beans	818	326	1,321
Cottonseed cake	-----	-----	2,955
Mexico			
Candelilla wax	1,411	5,557	5,644
Copra cake	----	4,060	2,416
Cottonseed cake	6,590	9,979	20,630
Soybean cake	----	----	7,444
Peru			
Cottonseed cake	----	----	1,053
Uruguay			
Flaxseed	49,931	37,012	105,327

Table 2. - Annual factory consumption of lauric acid-type soap oilss

Oil	Year	Total	Soap		Edible	
		1,000 lbs.	1,000 lbs.	%	1,000 lbs.	%
Coconut	1941	657,970	484,124	75.9	106,011	16.6
"	1940	528,203	396,857	75.1	94,048	17.8
"	1936-40	528,104	337,674	63.9	151,900	23.7
Babassu	1941	38,977	29,753	76.3	7,623	19.6
"	1940	55,431	41,221	74.3	12,288	22.1
"	1936-40	45,794	22,089	48.2	21,452	46.8
Palm-kernel	1941	10,364	1,113	11.7	7,877	76.0
"	1940	6,773	197	2.9	5,918	87.3
"	1936-40	51,487	34,202	66.5	15,046	29.2

Table 3. - Imports from Brazil of murumuru and tucum kernels, 1937-41

Year	Murumuru	Tucum
	1,000 pounds	1,000 pounds
1937	4,714	9,366
1938	4,101	2,328
1939	7,504	9,810
1940	6,001	5,032
1941	3,703	13,272
Total	26,023	39,808
5-yr. average	5,205	7,962

Table 4.- Estimated total consumption of fats and oils in the drying industries, United States, 1937-41.

Oils	1937	1938	1939	1940	1941
	1,000 lbs.	1,000 lbs.	1,000 lbs.	1,000 lbs.	1,000 lbs
Linseed	570,788	479,313	548,876	575,524	784,329
Tung	145,470	87,405	105,051	66,921	69,780
Fish	44,340	29,781	42,570	45,967	55,514
Soybean	17,157	18,847	28,220	37,164	49,515
Castor	7,722	6,043	11,844	24,857	46,295
Oiticica	3,651	5,301	18,867	15,537	36,578
Perilla	58,776	41,487	50,960	19,023	8,130
All other vegetable	2,723	2,080	2,179	2,811	5,647
Total	828,607	670,757	806,567	787,804	1,055,788

Table 5. - Production and exports of Brazilian oiticica oil 1934-1939

Year	Production in Brazil	Exports		Imports
		Ceará	Total Brazil	United States
	Pounds	Pounds	Pounds	Pounds
1934	----	----	180,000	----
1935	1,486,000	3,542,000	3,648,000	----
1936	13,806,000	6,050,000	7,260,000	2,886,995
1937	4,846,000	2,884,000	3,355,000	3,631,147
1938	31,876,000	5,882,000	8,194,000	5,300,899
1939	----	17,414,000	20,467,000	18,866,689
1940	----	----	15,950,000	15,536,623
1941	----	----	----	36,577,858

Table 6. - Imports of castor beans, 1936-41.

Year	Thousands of pounds
1936	164,077
1937	146,808
1938	114,072
1939	162,611
1940	237,789
1941	394,450

Table 7. - Flaxseed: Production in the Western Hemisphere by countries. (Thousands of bushels of 56 pounds.)

Year	Argentine	United States	Uruguay	Canada
1936	76,200	5,273	3,011	1,795
1937	60,605	7,089	3,728	774
1938	55,509	8,152	4,409	1,259
1939	39,935	20,152	4,693	2,044
1940	58,894	30,886	----	3,189
1941	66,925	31,485	----	6,473

Table 8. - Flaxseed produced, imported and crushed in the United States

Year	Domestic production	Imports	Seed crushed	Oil produced
	1,000 bu.	1,000 bu.	1,000 bu.	1,000 lbs.
1936	5,273	15,365	24,056	455,959
1937	7,089	28,032	35,967	665,099
1938	8,152	15,364	22,700	440,614
1939	20,152	16,028	28,868	584,508
1940	30,886	11,825	31,560	606,246
1941	31,485	21,122	44,854	868,057

Table 9. - Factory consumption of palm oil.

Year	Total	Edible products	Soap	Miscellaneous products, including tinplate	
	1,000 lbs.	1,000 lbs.	1,000 lbs.	1,000 lbs.	percent
1941	278,487	93,147	129,871	43,768	15.7
1940	157,213	36,309	84,934	32,302	20.6
1936-40	262,767	112,461	99,707	27,928	10.6